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PRACE INSTYTUTU GEOLOGICZNEGO

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JANUSZ KOPIK

**CALLOVIAN OF THE CZĘSTOCHOWA JURA
(SOUTH-WESTERN POLAND)**

**KELOWEJ JURY CZĘSTOCHOWSKIEJ
(POŁUDNIOWO-ZACHODNIA POLSKA)**

**КЕЛЛОВЕЙ ЧЕНСТОХОВСКОЙ ЮРЫ
(ЮГО-ЗАПАДНАЯ ПОЛЬША)**

WYDANO W SZEŚCZDZIESIĄTĄ ROCZNICĘ
POWSTANIA INSTYTUTU GEOLOGICZNEGO
1919 - 1979

WARSZAWA 1979

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(with 4 Figs. and 26 Pls.)

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Tłumacze:
Tekst angielski: dr Wojciech BROCHWICZ-LEWIŃSKI
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Summary

Litho- and biostratigraphic studies were carried out on Callovian deposits cropping out between Częstochowa (Wrzosowa) and Kłobuck (Walenczów) and, on somewhat smaller scale, on profiles of boreholes. Special attention was paid to biostratigraphic analyses and diachronism of some characteristic lithological members of the Callovian and lowermost Oxfordian (nodular and stromatolitic layers). The studies on ammonite sequences of the Częstochowa Callovian made it possible to propose a somewhat widened and modified stratigraphic subdivision of this stage for the studied area.

Detailed paleontological analyses covered Callovian ammonites of the family Kosmocerotidae Haug (genera and subgenera: *Keppelrites*, *Toricellites*, *Sigaloceras*, *Catasigaloceras*, *Kosmoceras*, *Zugokosmokeras*, *Gulielmiceras* and *Spinikosmokeras*) derived from the Częstochowa Jura. Apart from the descriptive systematic part, the paper contains given comments on paleogeographic and bioprovincial distribution of the taxa and on dimorphism in this ammonite family.

PART I

STRATIGRAPHY OF THE CALLOVIAN FROM THE AREA BETWEEN CZĘSTOCHOWA AND KŁOBUCK

INTRODUCTION

The studies on stratigraphy and paleontology of the Częstochowa Callovian, initiated in 1957, were continued with some longer breaks till 1967. They were primarily aimed at establishing bio- and lithostratigraphy of the Callovian of the Częstochowa Jura in the area between Wrzosowa in Częstochowa and Walenczów near Kłobuck (Częstochowa sedimentary region of the Polish Jura Chain¹), at about 30 km distance along the belt of outcrops of deposits of this stage (Figs. 1–2). The most important task was to gather and analyse Callovian ammonites which are highly common in these deposits.

The position of the Częstochowa Callovian sedimentary reservoir between the western and eastern European basins and strong influences of two main zoogeographic provinces, Boreal and Mediterranean, were highly unique, which is reflected by a specific character of ammonite assemblages occurring here.

It is a pleasure to express sincere thanks to all the colleagues whose benevolence and personal involvement made easier and accelerated my work: Warm thanks are especially due to Professor Dr. Jerzy Znosko for continuous interest in my work and its results and for fruitful comments on the manuscript.

Thanks are also due to Mrs. Czesława Dziewulska for help in the preparation of fossils, and to Dr. Jadwiga Karczewska, Hanna Ważyńska, M.Sc., and Danuta

Wojciechowska, M.Sc., for their help in collecting the fossils, to Mrs. Stanisława Pacuszka for the technical assistance in the preparation of the manuscript, and

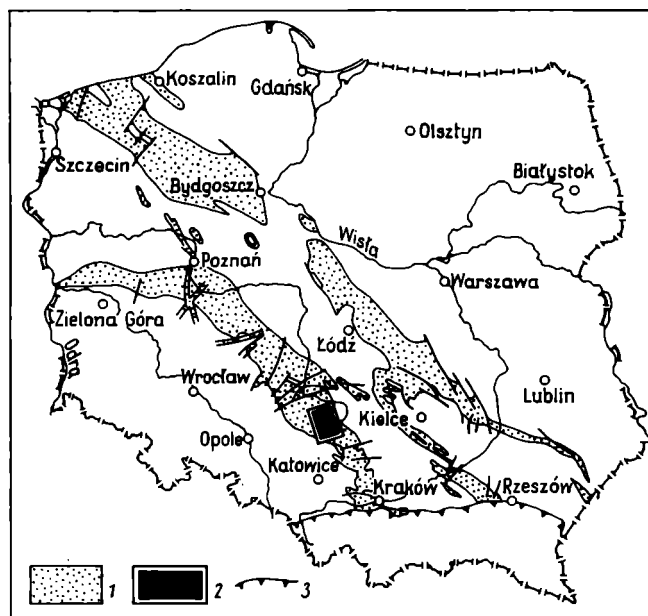


Fig. 1. Outcrops and Cenozoic subcrops of epicontinental Jurassic in Poland

1 - Jurassic cropping out on the surface or covered by younger deposits, 2 - studied area (Częstochowa Jura), 3 - boundary of Carpathian overthrust

1 - jura na wychodniach powierzchniowych i pod przykryciem osadów młodszych, 2 - teren obecnych badań (jura częstochowska), 3 - granica nasunięcia karpackiego

¹ The term proposed by S.Z. Różycki in 1960 (synonyms: Cracow - Wieluń Jura, Cracow - Częstochowa Jura, Cracow - Częstochowa Highland, etc.), with the reference to classic Jurassic ranges of western Europe, such as Schwabian and Franconian Jura (Alb) or Swiss and French Jura.

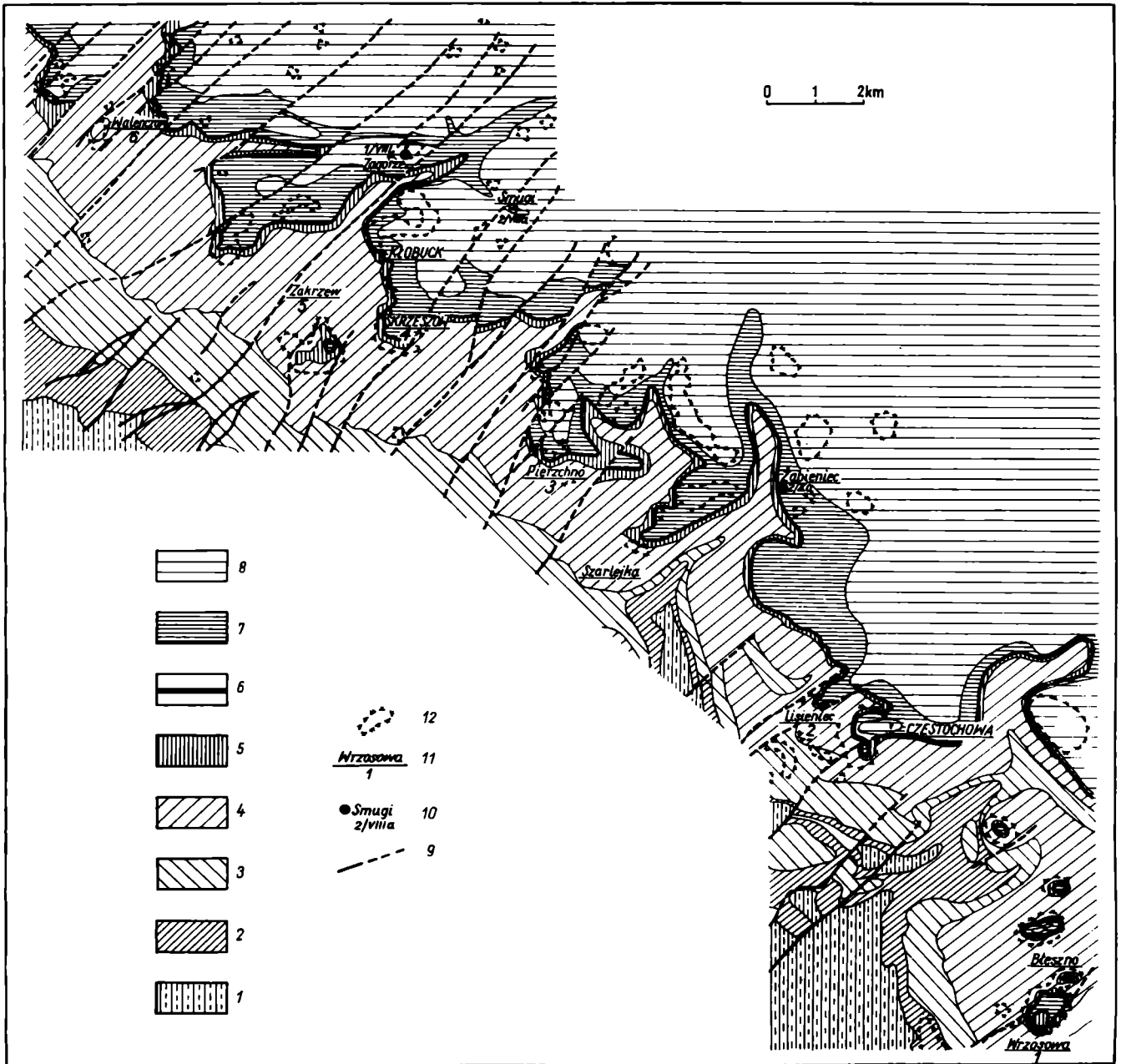


Fig. 2. Geological map (without post-Jurassic deposits, after Z. Mossoczy, somewhat modified)

1 - Upper Bajocian (Middle - Upper Kuiavian, partim), *Parkinsonia schoenbachi* - *Asphinctites tenuiplicatus* zones, ore-bearing Częstochowa clays, 2 - Lower Bathonian (*Procerites* spp. zone), ore-bearing Częstochowa clays, 3 - Middle Bathonian (*Morrisiceras morrissi* - *Cadomites bremeri* zones), ore-bearing Częstochowa clays, 4 - Upper Bathonian (*Oecotraustes heterocostatus* - *Clydoniceras discus* zones), upper part of ore-bearing Częstochowa clays and Częstochowa oolites, 5 - Lower Callovian (*Macrocephalites typicus* - *Sigaloceras calloviense*, partim, zones), 6 - Lower Callovian, partim - Lower Oxfordian, partim (*Sigaloceras calloviense*, partim - *Kosmoceras duncani*, *Quenstedtoceras flexicostatum*, *Q. lamberti* zones), nodular and stromatolitic layers, 7 - Lower Oxfordian (*Quenstedtoceras mariae* - *Cardioceras excavatum* zones), Jasna Góra Beds, 8 - Middle - Upper Oxfordian, 9 - dislocations, 10 - main Callovian profiles from drillings, 11 - Callovian and lowermost Oxfordian profiles described in the text, 12 - outcrops

Odkryta mapa geologiczna (według Z. Mossoczego, nieco zmieniona)

1 - bajos górny (środkowy - górny kujaw, partim), poziomy *Parkinsonia schloenbachi* - *Asphinctites tenuiplicatus*, częstochowskie iły rudonośne, 2 - baton dolny (poziom *Procerites* spp.) częstochowskie iły rudonośne, 3 - baton środkowy (poziom *Morrisiceras morrissi* - *Cadomites bremeri*) częstochowskie iły rudonośne, 4 - baton górny (poziomy *Oecotraustes heterocostatus* - *Clydoniceras discus*), górna część częstochowskich ilów rudonośnych i oolity częstochowskie, 5 - kelowej dolny (poziomy *Macrocephalites typicus* - *Sigaloceras calloviense*, partim), 6 - kelowej dolny, partim - oksford dolny, partim (poziomy *Sigaloceras calloviense*, partim - *Kosmoceras duncani*, *Quenstedtoceras flexicostatum*, *Q. lamberti*) warstwa bulasta i stromatolitowa, 7 - oksford dolny (poziomy *Quenstedtoceras mariae* - *Cardioceras excavatum*), warstwy jasnogórskie, 8 - oksford środkowy - górny, 9 - dyslokacje, 10 - ważniejsze profile wiertnicze kelowej, 11 - profile kelowej i najniższego oksfordu opisane w tekście, 12 - wychodnie

to Mrs. Danuta Oleksiak and Mrs. Romana Ufnal for the photos of rock specimens.

AN OUTLINE OF THE HISTORY OF GEOLOGICAL STUDIES

The earliest works by K. Oeynhausien (1822) and G.G. Pusch (1836–1837) contain very little information on the Callovian of the Cześćochowa Jura. More attention was paid to that subject much later, e.g. in the early papers of L. Zeuschner (1864, 1869), where it is discussed on a much wider scale.

Papers by E.A. Roemer (1867, 1870) contributed to the explanation of several principal questions in the stratigraphy of the Jurassic of the Cracow–Cześćochowa region but mainly in the case of lower members of the Middle Jurassic, and those of M. Neumayr (1871), G.C. Laube (1867a, b, c), A.E. Reuss (1867), A. Alth (1875), W. Szajnocha (1879) and others – to the knowledge of Callovian fauna of this region. The studies on the stratigraphy of the Cześćochowa Callovian were undertaken somewhat later by A. Michalski (1885). This author was first to describe a thin glauconitic layer (nodular layer of B. Reh binder) with highly diversified fauna of a few ammonite zones (*Macrocephalites macrocephalus*, partim – *Quenstedtoceras lamberti* zones).

G. Bukowski (1887b) published the first paleontological monograph of Callovian and Oxfordian ammonites of the Cześćochowa Jura and gave detailed lithological profiles of the Callovian. In his paper from 1890, S. Kontkiewicz described Callovian profile of the Jasna Góra quarries, very well exposed at these times. He also draw attention to a decrease in thickness of the Callovian from the north–west (Wieluń) to south–east (Cześćochowa). It is also worth to note his division of the Cracow–Wieluń Jura into two facies regions: the northern and the southern.

In 1894, J. Siemiradzki published a concise paleontological study of Callovian ammonites mainly derived from the Zawiercie area. A part of that faunal material was presented in his widely known monograph, of the genus *Perisphinctes* five years later (J. Siemiradzki, 1898–1899).

The concept of nodular layer was precised for the first time and the lithological member nowadays known as stromatolitic layer was first described by B. Reh binder in 1904. B. Reh binder also came to the conclusion that the structure of so called glauconitic layers is much more diversified than it was previously assumed. First of all, he differentiated a „platy” limestone layer (stromatolitic layer), up to 18 cm thick and characterized by generally fairly wide, regional extent but sometimes wedging out within the area of a single exposure. The contact of „platy” limestone with the underlying layer termed “nodular” (Knollenlager) by him is uneven, determined by specific structure of the latter. B. Reh binder favoured organic origin of these structures, interpreting them as sponge deposits on account of the wealth of sponge spicules in them.

P. Koroniewicz (1905) described several Callovian profiles including that from Wrzosowa, along with a fairly long list of fossils from the Wrzosowa quarry. In the paper from 1913, P. Koroniewicz and B. Reh-

binder presented results of their studies from the years 1909–1911, along with descriptions of newly exposed profiles of the Callovian (Jasna Góra profile).

Numerous valuable data on fauna and stratigraphy of the Cracow Callovian were given in the paper by K. Wójcik (1911).

After a long break resulting from the world war I, a new generation of researchers began studies on the Cześćochowa Jura. In 1924, J. Premik described profiles of the Callovian and Oxfordian from Wieluń and presented ammonite successions. S.Z. Różycki (1928) reported that he described several profiles of the Callovian and Oxfordian between Kłobuck and Cześćochowa and gathered a large collection of fossils. Two years later, S.Z. Różycki (1930) described localities of the nodular layer and gave lists of ammonites found in it in the vicinities of Żarki. In the same and the next year, J. Premik (1930, 1931) described outcrops of the Callovian in the vicinities of Cześćochowa, Kozięglowy and Kłobuck. He interpreted top surface of the Callovian as erosional (presumably in this way he interpreted polygonal structures from top surface of the stromatolitic layer).

In 1934, J. Premik presented a synthetic summary of the studies on the Cześćochowa Jura. Attention should be paid to the record of stratigraphic gap between the Callovian and Oxfordian. S.Z. Różycki (1938) was first to discover stromatolitic origin of limestones from top part of the nodular layer.

The events connected with the world war II resulted in a break in the publishing and research but as soon as 1947, appeared some notes on the Cześćochowa Callovian (J. Gołąb, 1947; Z. Mossoczy, 1947). In 1952, H. Makowski (unpublished report) analysed ammonite collection gathered by E. Ciuk and M. Żelichowska.

S.Z. Różycki (1953) published a large monograph on the Middle and Upper Jurassic deposits of the Cracow–Wieluń Jura. This work, representing only a part of regional stratigraphic monograph planned by this author still remains a fundamental synthesis of the stratigraphy of the Jurassic (mainly Middle Jurassic) of the Cracow–Cześćochowa region, despite of the loss of several of his manuscripts during the world war II. S.Z. Różycki presented there a new stratigraphic subdivision of the Callovian stage, including zones used in England and Germany and a new, *Macrocephalites typicus* zone. He also precised datings of stromatolitic and nodular layers, demonstrated their diachronism and determined the time span of stratigraphic gap between the Callovian and Oxfordian.

One year later, J. Znosko (1954a, b) presented some new data on Callovian profiles from drillings at Krzepice, Wręczyca and Rudniki. Brief remarks on the Callovian from the vicinities of Kłobuck, Danków and Walenczów were also given by Z. Mossoczy (1955). Some problems of the stratigraphy and lithology of Callovian deposits from drillings made in the Cześćochowa–Wieluń and Kalisz regions were also discussed in several papers by Z. Deczkowski (1959, 1960, 1963, 1976).

In connection with the Meeting of the Polish Geological Society in Cześćochowa in 1960, there were published several synthetic papers on the most important stratigraphic problems of the Callovian of the Cześćo-

chowa Jura (S.Z. Różycki, 1960a, b, c; J. Znosko, 1960b; Z. Mossoczy, 1960, and others).

A thorough study of Jurassic stromatolites including stromatolites from the boundary of the Callovian and Oxfordian in the Częstochowa area was published by M. Szulczewski in 1968. He rejected biological systematic of stromatolites, replacing it with a classification mainly based on stromatolite morphology and microstructure.

J. Kopik (1967) in a brief survey of the Middle Jurassic of the Częstochowa – Zawiercie area also precised the time span of the formation of nodular and stromatolitic layers on the basis of new paleontological data. In 1976 he described some less common Callovian ammonites from the Częstochowa Jura. K. Dayczak-Calikowska and J. Kopik (1976) presented a brief review of stratigraphic problems of the Middle Jurassic of the Częstochowa region in a synthesis of the Mesozoic of Poland.

The results of paleontological studies on the Callovian fauna of the Częstochowa Jura were presented in two extensive monographs of Jurassic belemnites and bivalves by H. Pugaczewska (1961, 1971) and irregular echinoids by W. Jesionek-Szymańska (1963). Other studies, more contributory in character, include the papers of J. Gołąb (1951) and R. Myczyński (1970) on ammonites of the genera *Proplanulites* and *Phlycticeras*, respectively. Two other papers, written by W. Krach (1934, 1951), deal with Callovian bivalves of the Cracow region.

DESCRIPTION OF EXPOSURES

VICINITIES OF CZĘSTOCHOWA

W r z o s o w a

The Callovian profile from Wrzosowa was surveyed by the present author in the years 1957–1964. The studies were carried out mainly in times when the Wrzosowa quarry was still active and it was possible to trace sequences of layers in quarry walls at distance of some hundred meters (Pls. I–IV).

Lower Oxfordian

Zones: *Cardioceras excavatum* – *C. bukowski*

1. Spongy marls and limestones (Jasna Góra Beds).

Zones: *Quenstedtoceras mariae* – *Q. flexicostatum*

2. Dark-green, marly glauconitic clay (0.005 m)². This deposits contains some not very characteristic foraminifers of the genera *Textularia*, *Spirillina*, *Trocholina* and others. This thin sedimentary coating originated in times when sedimentation was very strongly impeded, that is during the whole Divesian (*Quenstedtoceras flexicostatum* – *Q. mariae* zones).

3. Stromatolitic layer (0.03–0.12 m). It is formed of stromatolites convex upwards, columnar, delineated by network of interstices and forming characteristic polygonal structures in the horizontal projection (Pl. II, Fig. 1; Pl. VIII, Fig. 1). Lower surface of the stromatolitic layer is very closely adjusted to uneven top surface of nodular layer (Pl. VII, Fig. 1). Glauconitic clay lenses are sometimes found in the stromatolitic layer. The

² Thickness of deposits is given in brackets.

layer is usually continuous. When not, nodular layer directly contacts marly glauconitic clay layer (Pl. III, fig. 1). Isolated dome-shaped stromatolites are also occasionally found.

The stromatolitic layer from Wrzosowa is fairly rich in fossils in some places (Pl. IV, Fig. 1; Pl. IX, Figs. 2, 3, 4, 6). They were found here foraminifers: *Textularia jurassica* Gümbel, *Fronicularia* cf. *supracallovienensis* Wiśniowski, *Trocholina* cf. sp. 1 Lutze, *Paalzowella* sp., some sponges: kidney-shaped, spherical, monaxones and tetraxones, as well as gastropods: *Pleurotomaria agathis* Deslongchamps and fish teeth. There are also sometimes found belemnites (Pl. I, Fig. 3) and somewhat more frequently ammonites: *Binatisphinctes* (*Okaites*) cf. *mosquensis* (Fischer), *Indosphinctes* (*Elatmites*) *anomala* (Lóczy) (Pl. IX, Fig. 2), *Flabellisphinctes* sp., *Hecticoceras* (*Lunuloceras*) *compressum compressum* (Quenstedt), *H.* (*L.*) *lunuloides* (Kilian), *H.* (*L.*) *pseudopunctatum* Lahusen, *H.* (*Putealicerias*) aff. *svevum* (Bonarelli), *H.* (*Rossiensiceras*) sp. (Pl. IV, Fig. 1), *H.* (*R.*) cf. *metomphalum* (Bonarelli), *H.* (*Zieteniceras*) *evolutum* Lée, *Peltoceras* (*Peltoceras*) cf. *trifidum* (Quenstedt) (Pl. IX, Fig. 6), ? *Pseudopeltoceras* sp., *Kosmoceras* (*Kosmoceras*) *couffoni* Douville (Pl. IX, Fig. 3), *K.* (*K.*) *phaeinum* Buckman, *K.* (*Spinikosmokeras*) *ornatum* (Schlotheim).

Ammonites from the stromatolitic layer evidence the presence of the *Kosmoceras duncani* zone (*Peltoceras athleta* zone auct.), presumably upper horizons of this zone.

Upper Callovian – Lower Callovian, partim

Zones: *Kosmoceras duncani*, partim – *Sigaloceras calloviense*, partim

4. Nodular layer (0.08–0.18 m), composed of sandy limestone nodules varying in size (up to 20 cm long) and shape (usually kidney-shaped or ovate) embedded in green-yellowish marly cement along with numerous, commonly randomly oriented fossils (mainly ammonites, nautiloids, belemnites, echinoids, brachiopods and bivalves) (see Pl. VII, Figs. 1, 2). Mud balls or lenses of glauconitic clay may be often found in the cement. In top parts of this layer, a decrease in number of the nodules and occurrence of numerous accumulations of belemnite guards may be sometimes noted. The nodules are made of sandy limestones with some amount of phosphate compounds. Upper surface of nodular layer is uneven and wavy on account of irregular distribution of pebbles and nodules and large fossils occurring in this layer. Denivellations in the top of the nodular layer are usually overgrown by stromatolites which are closely adjusted to diversified bedrock relief (Pl. VII, Fig. 1; Pl. VIII, Fig. 3). In single cases, when the stromatolitic layer is missing, top surface of the nodular layer is almost rectilinear. This is undoubtedly due to moderately intense erosional processes which preceded deposition of thin glauconitic clay-marly layer (Pl. III, Fig. 1). These processes were also active when the stromatolitic layer was somewhat reduced in thickness (Pl. III, Fig. 2).

Fossils belong to more important components of this layer. The number and differentiation of particular taxonomical groups are so large (several hundred species) that only some more important or common species may be listed here; nautiloids: *Pseudaganides kutchensis* (Waagen); belemnites: *Belemnopsis canali-*

culatus (Schlotheim), *Hibolites girardoti* (Loriol), *Belemnopsis parallelus germanicus* (Roemer); echinoids: *Collyrites* (*Cardiopelta*) *bicordata primitiva* Jesionek-Szymańska, *Dicraster moeschi* Désor; brachiopods: *Rhactorhynchia sublucunosa* (Szajnocha), *Dorsoplicathyrus dorsoplicata* (Suess); ammonites: *Calliphylloceras demidoffi* (Rousseau), *Ptychophylloceras flabellatum* (Neumayr), *Thraxites depereti* (Lemoine), *Strungia vultensis* Elmi, *Erymnoceras* (*Erymnoceras*) *doliforme* Roman, *E. (E.) baylei* Jeannet, *E. (Erymnoceras)* *leuthardti* (Rollier) Jeannet, *E. (Rollierites)* *ajax* (d'Orbigny) Jeannet, *Lissoceras vultense* (Oppel), *Sigaloceras* (*Catasigaloceras*) *enodatum* (Nikitin), *Kosmoceras* (*Zugokosmoceras*) *ex gr. jason* (Reinecke) d'Orbigny, *K. (Z.) obductum* (Buckman), *K. (Kosmoceras)* *nestor* sp. n., *K. (K.) jenzi* gracile subsp. n., *K. (K.) clavifer* Tintant, *K. (K.) phaeinum* (Buckman), *K. (K.) proniae* Teisseyre, *K. (K.) fibuliferum* (Buckman), *K. (Spinikosmoceras)* *castor* (Reinecke), *K. (S.) pollux* (Reinecke), *K. (S.) ornatum* (Schlotheim), *K. (S.) torosum* sp. n., *Hectoceras* (*Rossienceras*) *metomphalum* Bonarelli, *H. (Putealicerias)* *punctatum* (Stahl), *H. (P.) krakoviense* (Neumayr), *H. (Lunuloceras)* *compressum* (Quenstedt), *Reineckeia* (*Loczyeras*) spp., *R. (Reineckeia)* *substeinmanni* Lemoine (= *R. anceps* auctt.), *R. (Kellawaysites)* *oxyptycha* (Neumayr), *R. (K.) falcata* Till, *R. (Reineckeites)* *ex gr. stuebeli* Steinmann, *R. (R.) mangoldi* Bourquin, *Macrocephalites* (*Pleurocephalites*) *perseverans* (Model) Jeannet, *M. (Pleurocephalites)* *tumidus* (Reinecke), *M. (P.) folliformis* Buckman, *M. (Macrocephalites)* *cannizzaroi* Gemmellaro, *M. (Kamptokephalites)* *subtrapezinus* (Waagen), *Binatisphinctes* (*Okaites*) *mosquensis* (Fischer), *B. (O.) polonicus* (Siemiradzki), *Hoffatia* (*Grossouvria*) *kontkiewiczzi* (Siemiradzki), *Ch. (G.) tenella* (Teisseyre), *Ch. (Hoffatia)* *pseudofunata* (Teisseyre), *Flabellisphinctes* (*Flabellia*) *tsytovitchae* Mangold and others.

Other groups of fossils present here include bivalves and gastropods (numerous *Pleurotomaria* spp.), as well as some sponges, bryozoans and annelids (*Glomerula*). Moreover, microfossils are more or less common in clay-marly cement; foraminifers: *Spirillina polygyrata* Gümbel, *S. tenuissima* Gümbel, *Paalzowella pazdroae* Bielecka et Styk, skeletal elements of echinoids and juvenile gastropod shells often preserved as glauconitic moulds.

Lower Callovian

Sigaloceras calloviense zone

5. Greenish-grey, knobby sandy limestone with glauconite and sometimes with clearly marked traces of iron oxide infiltration (0.13–0.16 m). Fauna is fairly numerous but monotonous. Brachiopods predominate: *Dorsoplicathyrus dorsoplicata* (Suess), along with echinoids: *Collyrites* (*Cardiopelta*) *bicordata primitiva* Jesionek-Szymańska, and nautiloids: *Pseudaganides kutchensis* (Waagen). Ammonites are not very common: *Hectoceras* (*Zieteniceras*) *balinense* (Bonarelli), *Macrocephalites* sp., Perisphinctidae indet. Belemnites are also present here: *Belemnopsis subhastatus* (Zieten) and *Hibolites hastatus* (Blainville).

6. Brownish sandy limestones, greenish close to the top and passing towards the base into massive ones, characterized by cavity weathering (0.40 m). Fauna is innumerable here, being represented by belemnites

Belemnopsis canaliculatus (Schlotheim), some brachiopods and occasional echinoids, *Collyrites* sp.

7. Brownish, sandy platy limestones (0.27 m).

8. Grey-greenish, strongly clayey and glauconitic marls (0.04–0.07 m).

9. Brownish, sandy limestones (0.23 m) with *Belemnopsis canaliculatus* (Schlotheim) and *Hibolites hastatus* (Blainville).

10. Grey-greenish, strongly clayey and glauconitic marls with fairly numerous belemnites (0.06 m).

11–19. Brownish, sandy limestones (0.82 m) with numerous intercalations of marls as above (0.19 m).

20. Light-grey with greenish shade, sandy marl becoming more massive, knobby and spotted towards the base (0.06 m). Ammonites are numerous but usually unidentifiable.

21. Brownish limestones, somewhat marly and knobby in the top, massive and hard below (0.10 m). White, kaolinitic ooids are sometimes common here. Some parts of the rock are filled with ammonites which are, however, hardly identifiable as their moulds are brittle and ornamentation corroded (table IX, fig. 5). In the layers 20–21 were found: *Indosphinctes* (*Elatmites*) sp., *Sigaloceras* (*Sigaloceras*) cf. *calloviense* (Sowerby), ? *Proplanulites* sp., *Macrocephalites* sp., *Kepplerites* (*Torricellites*) cf. *lahuseni* Parona et Bonarelli, *K. (Gowericeras)* sp. ex gr. *gowerianus* (Sowerby), *Belemnopsis canaliculatus* (Schlotheim), *B. subhastatus* (Zieten). The presence of representatives of the genera *Sigaloceras*, *Torricellites* and *Gowericeras* may indicate that the layers 20–21 still belong to the *Sigaloceras calloviense* subzone.

Macrocephalites typicus zone

22. Massive, brownish limestones, somewhat marly in the top, with kaolinitic ooids (0.42 m). No faunal remains were found.

Upper Bathonian (Częstochowa oolites)

23–25. Brownish, grey and greenish clays with numerous flattened limonitic ooids, fragments of carbonized wood and belemnites (0.52 m).

Summative thickness of the Callovian from Wrzosa is 2.70 m.

Częstochowa – Lisieniec

Lower Oxfordian (“Neuvisian” – Upper “Divesian”)

Zones: *Cardioceras bukowskii* – *Quenstedtoceras mariae*

1. Spongy limestones and marls with numerous *Cardioceras* spp.

? *Quenstedtoceras lamberti* zone

2. Dark-green, marly clay (0.005 m).

Lower Oxfordian (Lower “Divesian” – Upper Callovian, partim).

Zones: *Quenstedtoceras flexicostatum* – *Kosmoceras duncani*, partim

3. Stromatolitic layer of the polygonal type (0.11 m), sometimes with mud balls and sharp-edged fragments of greenish clays. It comprises ammonites: *Hectoceras* (*Putealicerias*) *krakoviense ogivale* (Tsytoitch),

H. (P.) krakoviense krakoviense (Neumayr), Perisphinctidae indet., and unidentifiable belemnites.

Upper Callovian – Lower Callovian, partim

Zones: *Kosmoceras duncani*, partim – *Sigaloceras calloviense*, partim

4. Nodular layer, typically developed (0.16–0.18 m) and rich in fossils. Attention should be paid to fairly common flat lying belemnite guards. Moreover, there were found: *Kosmoceras (Zugokosmokeras?) balticum* Krenkel, *K. (Kosmoceras) nestor* sp. n., *K. (Spinikosmokeras) torosum* sp. n., *K. (S.) pollux* (Reinecke) and others.

Lower Callovian

Sigaloceras calloviense zone

5. Grey-greenish knobby, spotted limestone, in places infilled with brachiopods *Dorsoplicathyris dorsoplicata* (Suess). Towards the base, it becomes more massive and contains irregular lenses of green, massive marls (0.33 m).

6. Dark-brownish and chocolate, massive limestone (0.36 m). The thickness of Callovian deposits exposed here is about 1 m. Other parts of the profile are not exposed here, and brownish, oolitic limestones of the lowermost Callovian (*Macrocephalites typicus* zone), with unidentifiable specifically fragments of *Macrocephalites* sp. may be found among loose blocks of Callovian rocks in the waste in the fields.

VICINITIES OF KŁOBUCK

The outcrops of the Callovian from the Kłobuck area, similarly as those from Częstochowa, were discussed and described in the geological literature at least for several decades. Their detailed descriptions along with lists of fossils were given for the last time by S.Z. Różycki (1953).

P i e r z c h n o

The summative profile of the Callovian and lowermost Oxfordian, made on the basis of three outcrops, was as follows:

Lower Oxfordian (Upper "Divesian")

Quenstedtoceras mariae zone

1. Sponge limestones and marls with *Quenstedtoceras (Vertumnoceras) mariae* (d'Orbigny), about a dozen cm thick.

Quenstedtoceras lamberti zone

2. A layer of dark-green, glauconitic marly clay (0.005 m).

Zones: *Quenstedtoceras lamberti*, partim – *Quenstedtoceras flexicostatum*, partim

3. Stromatolitic layer of the polygonal type (0.10 m).

Lower Oxfordian, partim – Lower Callovian, partim

Zones: *Quenstedtoceras flexicostatum*, partim – *Sigaloceras calloviense*, partim

4. Nodular layer (0.10–0.12 m), consisting of nodules and pebbles of hard, dark-brownish, ferruginous sandy limestones often with limonitic coating and corroded surface with numerous depressions, embedded in yellow-greenish marly cement. Annelid *Glomelura* calcareous tubes are fairly common on surface of these

nodules. Fossils with bulgy shell, as e.g. *Macrocephalites*, are usually preserved as moulds. They are usually corroded or even worn out. Fauna is fairly numerous and specifically diversified. The share of ammonites of the genus *Macrocephalites* is fairly high. There were found here *Macrocephalites (Dolikephalites) subcompressus* (Waagen), *M. (Pleurocephalites) tumidus* (Reinecke), *M. (P.) folliiformis* Buckman. They are accompanied by *Kosmoceras (Kosmoceras)* cf. *caucasicum* Chikhachév, *K. (Spinikosmokeras) castor* (Reinecke), Perisphinctidae, *Hecticoceras* spp. as well as the representatives of other groups as bivalves and echinoids. There were also found here *Hecticoceras (Hecticoceras)* sp. which, along with some other species such as *Macrocephalites (Dolikephalites) subcompressus* (Waagen) or *Oxycerites subcostarius* (Oppel) may date the initial stages of formation of the nodular layer (*Sigaloceras calloviense* subzone). S.Z. Różycki (1953) reported also species typical of the lowermost Oxfordian (Lower "Divesian"), as e.g. *Quenstedtoceras (Bourkelamberticeras) flexicostatum* (Phillips), from this layer.

Lower Callovian

Sigaloceras calloviense zone

5. Grey-greenish, sometimes spotted, sandy, glauconitic knobby limestones (0.35 m) with fauna mainly consisting of brachiopods, *Dorsoplicathyris dorsoplicata* (Suess), and echinoids, *Collyrites (Cardiopelta) bicordata primitiva* Jesionek-Szymańska, some belemnites, *Hibolites hastatus* (Blainville), and occasional ammonites, *Macrocephalites* sp.

6. Green-grey or brownish, spotted, sandy limestones, sometimes slightly knobby and with characteristic cavity weathering (0.40 m).

7–11. Grey-greenish or brownish, sometimes spotted, massive, sometimes knobby, sandy limestones with marly intercalations (2.34 m).

The thickness of Callovian deposits exposed here was about 3.20 m. Lower parts of the Lower Callovian profiles were inaccessible in these exposure.

S k r z e s z ó w

Lower Oxfordian

Quenstedtoceras mariae zone

1. Sponge limestones and marls about a dozen cm thick and containing *Quenstedtoceras (Bourkelamberticeras) loriolli* Maire and *Q. (B.) henrici* Douvillé.

Quenstedtoceras lamberti zone

2. Dark-green, marly clay layer (0.005–0.02 m).

3. Stromatolitic layer (0.08–0.20 m) formed of columnar (of the polygonal type) and grooved stromatolites (Pl. V, Fig. 2; Pl. VI). Upper surface of stromatolitic layer is relatively even and covered by a very thin layer of greenish glauconitic marly clay, whereas the lower closely adjoins wavy and uneven top surface of the nodular layer. In some places, brownish calcareous nodules formed in result of scouring of the nodular layer in the neighbourhood, may be noted in the stromatolitic layer (Pl. VI, Fig. 2). Stromatolites often overgrow fossils such as ammonites or belemnites, rising above the surface of the nodular layer. In the stromatolitic layer there were found: *Hecticoceras (Pu-*

tealicer) cf. *krakoviense ogivale* Tsytoich, *H. (Rossien-sicer)* cf. *rossiense latum* Zeiss, *Quenstedtoceras weis-sermeli* Maire, *Quenstedtoceras* sp., *Belemnopsis canaliculatus* (Zieten), *Lucina* sp. (Pl. VI, Fig. 1).

Lower Oxfordian – Lower Callovian, partim

Zones: *Quenstedtoceras flexicostatum* – *Sigaloceras calloviense*, partim

4. Nodular layer (0.20 m) (Pl. V, Fig. 2) composed of a large number of ovate, irregular and often kidney-shaped pebbles and calcareous-phosphate nodules, sometimes displaying borings. Spaces between nodules and fossils are filled with yellowish-green marl with small, lenticular intercalations of green clays. Ammonites are very numerous here but usually broken, often with corroded shell (and especially destroyed lower part of shell) and deprived of body chambers.

Fauna is usually randomly scattered in the nodular layer, and fossils are redeposited and mixed up. Traces of weak selection, which may be occasionally noted, include accumulations of flat lying belemnite guards. Fossils are often covered with a thin, fine coating of dark-green, glauconitic clay. Ammonites most common in this layer include: unidentifiable Perisphinctidae, *Hecticoceras*, *Kosmoceras*, including *Kosmoceras (Spinikosmokeras) torosum* sp. n., *K. (S.) castor* (Reinecke), *K. (S.) pollux* (Reinecke), *K. (Zugokosmokeras) subnodatum* Teisseyre, *K. (Kosmoceras) castorinum wrzosiowiense* subsp. n., and *Reineckea*. They are accompanied by markedly rarer *Quenstedtoceras (Bourkelamberticeras) ex gr. flexicostatum* (Phillips) and *Macrocephalites (Pleurocephalites) folliformis* Buckman. In the nodules, fossils are very rare, being mainly represented by small-sized specimens of *Macrocephalites*.

Lower Callovian

Sigaloceras calloviense zone

5. Sandy, knobby, greenish-grey limestones (0.42 m). Fauna is here markedly less numerous than in the overlying layer. A characteristic faunal assemblage predominating here consists mainly of brachiopods, echinoids, and some nautiloids: *Dorsoplicathyris dorsoplicata* (Suess), *Collyrites (Cardiopelta) bicordata primitiva* Jesionek-Szymańska, *Pseudaganides kutchensis* (Waagen). Ammonites are fairly rare, being represented by *Choffatia (Grossouvria) subtilis* (Neumayr), *Ch. (Subgrossouvria) coronaeformis* (Lóczy).

8–18. Sandy, massive, dark-brown and marly limestones with intercalations of grey-greenish marls (2.60 m).

19. Marly, dark-yellow and light-brown limestones with knobby structure, irregularly interfingering with marls (0.92 m). They contain fairly numerous, flat lying belemnites. A chert nodule (19 × 21 cm) was found 0.25 m above the sole of these limestones. Higher up (0.25 m from the top), cherts are occasionally found.

Macrocephalites typicus zone

20–24. Dark-brown, massive, and yellow, sandy limestones with numerous cherts, and marls and marly limestones (1.58 m). Callovian deposits (including the nodular layer), exposed here, are 5.70 m thick. The lowermost layers of the Lower Callovian were not traced in this exposure. It follows from the comparisons of thicknesses of this stage in this region that oolitic

deposits of the uppermost Bathonian occur not deeper than some dozen cm below the base of the last layer described in the profile.

Walenczów

Lower Oxfordian

Quenstedtoceras mariae zone

1. Spongy marls and limestones (about a dozen cm thick), containing nodules derived from the upper parts of the Callovian in their lower parts.

2. A layer of dark-greenish marly clay (0.005–0.02 m). In deposits resting directly on stromatolitic layer (layers 1 and 2) are often found large (up to 9 × 5 cm in size), kidney-shaped, grey-green and brownish calcareous nodules. These nodules, redeposited, presumably originated from scouring of the nodular layer. Large (up to 10 × 3 cm in size) exotics of dark-greenish clays are less common here. In the first two layers there was also found redeposited large Early Callovian ammonite *Macrocephalites (Dolikephalites) subcompressus* (Waagen) (Pl. IV, Fig. 2).

Quenstedtoceras lamberti zone

3. Stromatolitic layer (0.12–0.18 m) with the following fossils: unidentifiable Perisphinctidae, *Quenstedtoceras (Prorsiceras) cf. gregarium* (Leckenby) and fairly numerous, usually flat lying belemnites.

Lower Oxfordian – Lower Callovian, partim

Zones: *Quenstedtoceras flexicostatum* – *Sigaloceras calloviense*, partim

4. Nodular layer (0.13–0.23 m), more marly above and more massive, coarsely nodular below. Traces of activity of boring organisms and annelid tubes may be sometimes noted on dark-brownish nodules with limonitic coating. In the faunal assemblage comprising common Late Callovian species, predominate ammonites: *Macrocephalites (Pleurocephalites) spp.* and *M. (P.) folliformis* Buckman and others. Attention should be also paid to the occurrence of the oldest representatives of the genus *Kosmoceras (Kosmoceras (Gulielmiceras) gulielmi anterior* Brinkmann) and the last *Sigaloceras (Sigaloceras (Catasigaloceras) enodatum* (Nikitin)) in this layer. Sponges are also occasionally recorded here.

Lower Callovian

Sigaloceras calloviense zone

5–6. Knobby, grey-greenish, sandy (0.52 m) and massive, brownish (1.20 m) limestones. The thickness of exposed sections of the Callovian and lowermost Oxfordian is about 2.20 m. Other parts of the profile were inaccessible for studying.

SELECTED PROFILES OF THE CALLOVIAN
FROM BOREHOLES MADE IN THE AREA BETWEEN
CZĘSTOCHOWA AND KŁOBUK

ZABIENIEC 2/Xa BOREHOLE

Neither profile of the Żabieniec 2/Xa borehole nor that of the Smugi 2/VIIIa borehole could be recognized as representative on account of strongly destroyed

core material. The former profile is, however, situated in the area without outcrops (6 km from the Jasna Góra and about 5 km from the Pierzchno outcrops) and made possible correlation of Callovian deposits from the two above mentioned areas and evaluation of thickness of deposits of that stage.

Zones: *Quenstedtoceras flexicostatum* – *Sigaloceras calloviense*, partim

34.60–34.85 (?) m. Stromatolitic and nodular layers (fragments)

Sigaloceras calloviense zone

34.85 (?)–37.40 m Limestones, in places dolomitic, sandy, grey-greenish and yellowish, massive, sometimes spotted and marly, with grey-greenish marl intercalations

? *Macrocephalites typicus* zone

37.40–38.40 m Green-grey marls (0.40 m) and dolomitic limestones, dark-grey, hard, massive, with fairly numerous ooids and marly intercalations in lower part

The Callovian from the Żabieniec 2/Xa borehole is 3.80 m thick, that is 1.10 m thicker than at Wrzosowa, and 1.05 m thinner than in the Smugi 2/VIIIa borehole and more than 2 m thinner than in the Kłobuck area (Fig. 3). Because of the lack of fossils in this profile, the stratigraphic subdivision was made on the basis of correlative premises.

SMUGI 2/VIIIa BOREHOLE

The borehole Smugi 2/VIIIa was situated about 3 km NNE of Kłobuck. The thickness of the Callovian here increases to 4.85 m.

Zones: *Quenstedtoceras lamberti* – *Sigaloceras calloviense*, partim

39.95–40.15 (?) m Fragments of stromatolitic and nodular layers

Sigaloceras calloviense zone

40.15 (?)–40.90 m Massive, dolomitic limestones, greenish-grey in colour, in places very soft, spotted

40.90–43.20 m Light-pink limestones, grey-greenish in the top, massive, dark-brown below, massive, with fragments of light limestones (a large loss of core)

? *Macrocephalites typicus* zone

43.20–43.80 m Dolomitic, brown-yellow, grey, massive limestones with cherts, passing downwards into light-grey and grey-green, hard glauconitic marls with limestone intergrowths; *Macrocephalites* spp., *M. (Dolikephalites)* sp. cf. *typicus* (Blake)

43.80–44.10 m Sandy, grey, glauconitic marls with intergrowths of grey and greenish, massive limestones; *Macrocephalites* sp. indet.

44.10–44.30 m Dark-grey, in places glauconitic marls with irregular concentrations of ferruginous ooids; *Macrocephalites* sp.

44.30–44.80 m Dolomitic, massive, grey-greenish limestones with innumerous ooids

STRATIGRAPHY

LOWER CALLOVIAN

Macrocephalites typicus zone

The lowermost sections of the Callovian, representing the *Macrocephalites typicus* zone, were recorded at Wrzosowa, Częstochowa, and Skrzyszów near Kłobuck, as well as in the two boreholes situated between

Częstochowa and Kłobuck (Żabieniec 2/Xa and Smugi 2/VIIIa).

The *Macrocephalites typicus* zone was differentiated in the area of the Cracow–Wieluń Jura for the first time by S.Z. Różycki (1953). This author also listed other ammonite species, *Proplanulites koenigi* as an auxiliary index species for this zone. The latter is accepted as characteristic in the stratigraphic scheme for the Lower Callovian of western Europe (J.H. Callomon, 1955, 1964; W.J. Arkell, 1956; E. Cariou and others, 1971a, b) and occurs in the lowermost part of the *koenigi* subzone of the *Sigaloceras calloviense* zone (Table 1). Actually, the *Proplanulites koenigi* subzone was not subordinated to the *Macrocephalites typicus* zone in the S.Z. Różycki (1953) zonal scheme. This is suggested by the records of the species *P. koenigi* (Sowerby) in faunal assemblages of the *Sigaloceras calloviense* zone, given elsewhere by that author.

The species *Macrocephalites (Dolikephalites) typicus* (Blake) is relatively scarce in the Lower Callovian of the Częstochowa Jura. Despite of fairly wide total vertical range of this species, from the *Macrocephalites kamptus* subzone to the *Sigaloceras calloviense* zone (H. Tintant, J. Thierry, 1974), and its first appearance presumably not coinciding with the base of the Callovian, it may be treated with some reservation as a zonal fossil of the basal horizon of the Callovian of the Cracow–Wieluń Jura at the present state of studies. The species *Macrocephalites macrocephalus* (Schlotheim), widely accepted as standard zonal species, is characterized by wider stratigraphic range and its diagnosis is somewhat ambiguous.

The faunal assemblage of the *Macrocephalites typicus* zone from the Częstochowa area is rather poor in guide ammonite species. Besides fairly rare index species, there were found here numerous unidentifiable representatives of the genus *Macrocephalites* and presumably first, very rare and poorly preserved Kosmoceratidae: *Keplerites* cf. *kepleri* (Oppel) (Szarlejka locality, coll. J. Premik).

The standard, *Macrocephalites macrocephalus* zone represents partial equivalent of the *Macrocephalites typicus* zone in the west-European zonal schemes. The paleontological data available are, however, insufficient for unequivocal statement which faunistic equivalents of the *macrocephalus* zone fall within the range of the *typicus* zone. Similarly, it is still debatable whether the upper boundary of the *Macrocephalites typicus* zone sensu Różycki coincides precisely with the top of the *macrocephalus* zone sensu anglico (*Macrocephalites kamptus* subzone) or, which is more probable, the top of the *koenigi* subzone.

Sigaloceras calloviense zone

In currently used stratigraphic subdivisions, this zone is divided into two subzones: lower, *Sigaloceras calloviense* and upper, *Sigaloceras enodatum*. Up to the present, there is no faunistic evidence for the presence of the lowermost standard subzone of the *calloviense* zone, e.g. the *Proplanulites koenigi* subzone.

In the Częstochowa area, a thin (merely some dozens cm thick) layer of ooid-bearing limestones of the *Macrocephalites typicus* zone directly contacts deposits with typical ammonite assemblage of the *Sigaloceras calloviense* subzone. This may suggest that the deposits

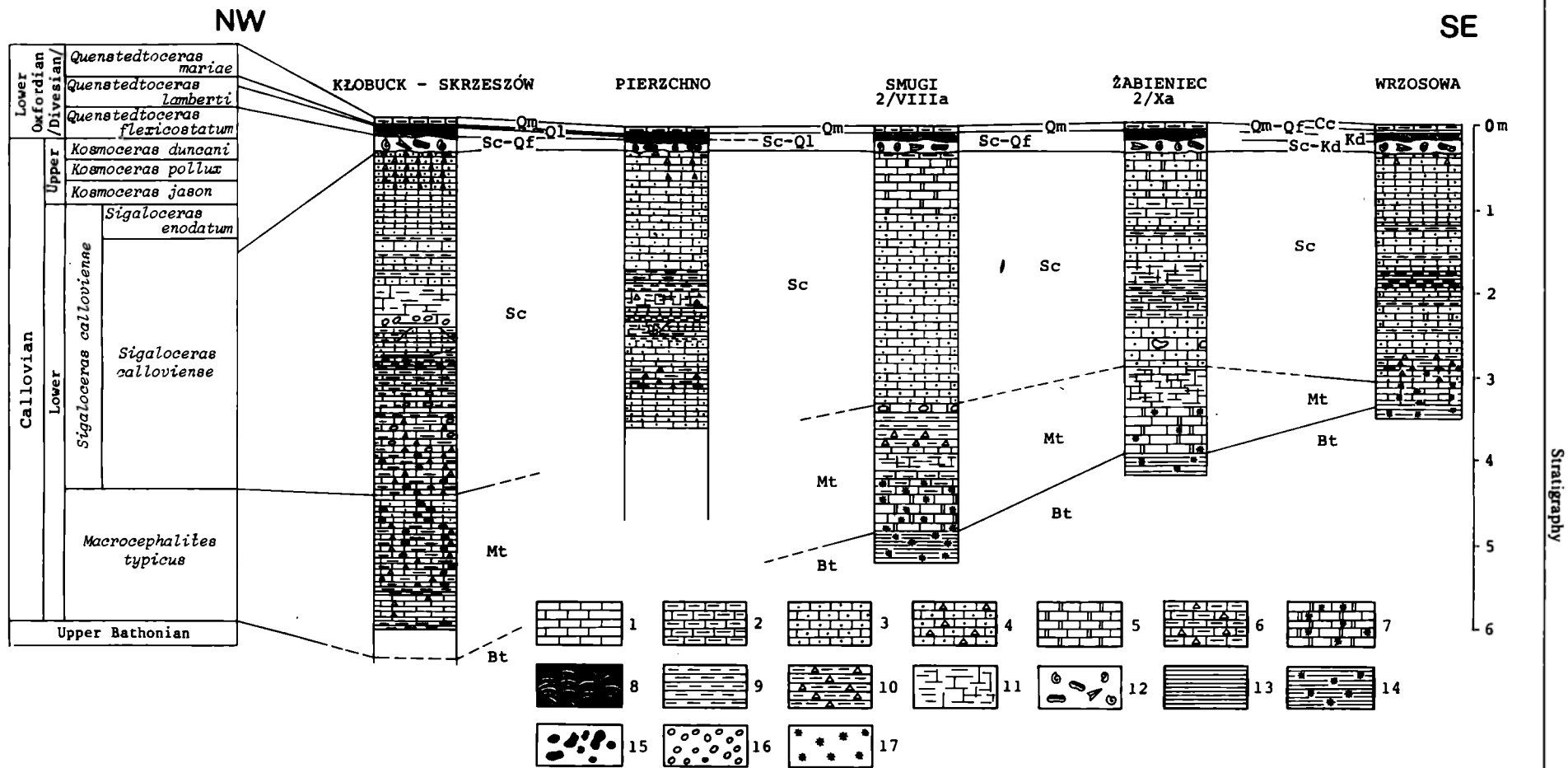


Fig. 3. Correlation of profiles of the Callovian and lowermost Oxfordian from outcrops and drillings in the area between Kłobuck and Wrzosowa

1 - limestone, 2 - marly limestone, 3 - sandy limestone, 4 - nodular limestone, 5 - dolomitic limestone, 6 - marly nodular limestone, 7 - dolomitic limestone with ooids, 8 - stromatolitic layer, 9 - marls, 10 - nodular marls, 11 - marls in places with calcite cement, 12 - nodular layer, 13 - clays, 14 - oolitic clays, 15 - flints, 16 - cherts, 17 - ooids; Bt - Bathonian, Mt - *Macrocephalites typicus* zone, Sc - *Sigaloceras calloviense* zone, Kd - *Kosmoceras duncani* zone, Qf - *Quenstedtoceras flexicostatum* zone, Ql - *Quenstedtoceras lamberti* zone, Qm - *Quenstedtoceras mariae* zone, Cc - *Cardioceras cordatum* zone

Korelacja profiliów keloweju i najniższego oksfordu w odsłonięciach i otworach wiertniczych między Kłobuckiem a Wrzosową

1 - wapień, 2 - wapień marglisty, 3 - wapień piaszczysty, 4 - wapień gruzłowaty, 5 - wapień dolomityczny, 6 - wapień marglisty, gruzłowaty, 7 - wapień dolomitowy z ooidami, 8 - warstwa stromatolitowa, 9 - margle, 10 - margle gruzłowane, 11 - margle z lokalną cementacją wapienną, 12 - warstwa bulasta, 13 - iły, 14 - iły oolityczne, 15 - krzemienie, 16 - czerty, 17 - ooidy; Bt - baton, Mt - poziom *Macrocephalites typicus*, Sc - poziom *Sigaloceras calloviense*, Kd - poziom *Kosmoceras duncani*, Qf - poziom *Quenstedtoceras flexicostatum*, Ql - poziom *Quenstedtoceras lamberti*, Qm - poziom *Quenstedtoceras mariae*, Cc - poziom *Cardioceras cordatum*

corresponding to the *koenigi* subzone here still belong to the *Macrocephalites typicus* zone.

As it was already stated, the paleontological record of the *Sigaloceras calloviense* zone is much better than that of the underlying zone in the Częstochowa Jura area, but the number of localities with guide fossils as well as the preservation of these fossils are not fully satisfactory.

From the strata of this zone exposed in the Jasna Góra profile, S.Z. Różycki (1953) reported index species *Sigaloceras* (*Sigaloceras*) *calloviense* (Sowerby) as well as some specifically unidentifiable *Kepplerites* and *Macrocephalites* (*Macrocephalites*) *macrocephalus* (Schlotheim). The representatives of these species were said to be most common in a characteristic knobby layer of brownish sandy limestones (Pl. IX, Fig. 5) directly overlying oolitic limestones of the *Macrocephalites typicus* zone. In this layer occur kaolinitic ooids and numerous hardly identifiable flattened ammonite moulds (layer 10 in the Jasna Góra profile according to S.Z. Różycki, 1953). The studies carried out later by the present author gave support to the suggestions made by S.Z. Różycki, and exploitation of fauna from this layer somewhat supplemented the list of species characterizing this ammonite zone.

At Wrzosowa, where these deposits were well exposed in the past (layers 20–21), there were found the following species of the *Sigaloceras calloviense* subzone: *Sigaloceras* (*Sigaloceras*) cf. *calloviense* (Sowerby), *Kepplerites* (*Toricellites*) cf. *lahuseni* (Parona et Bonarelli), *K.* (*Gowericeras*) sp. ex gr. *gowerianus* (Sowerby), occasional *Proplanulites* of uncertain taxonomic position and other, less important species.

Fauna of upper parts of the Lower Callovian is also neither numerous nor well preserved. Most common are here belemnites (sometimes occurring in somewhat larger numbers): *Hibolites hastatus* (Blainville), *Belemnopsis canaliculatus* (Schlotheim), *B.* cf. *latesulcatus* (d'Orbigny), *B. subhastatus*. They are accompanied by specifically unidentifiable and often attaining large dimensions ammonites of the genus *Macrocephalites*, some unidentifiable Perisphinctidae, and some bivalves and echinoderms.

A layer of greenish knobby limestones is first to contain somewhat larger number of fossils which, however, are not always of a greater stratigraphic value. Here occurs characteristic ecological assemblage of brachiopods, echinoids and nautiloids: *Dorsoplicathyrus dorsoplicata* (Suess), *Collyrites* (*Cardiopelta*) *bicordata primitiva* Jesionek-Szymańska and *Pseudaganides kutchensis* (Waagen). There also occur some ammonites characteristic of the *Sigaloceras calloviense* subzone or known from that subzone: *Hecticoceras* (*Zieteniceras*) *balinense* (Bonarelli), *Choffatia* (*Grossouvria*) *subtilis* (Neumayr), *Ch.* (*Subgrossouvria*) *coronaeformis* (Lóczy), *Macrocephalites* sp.

The deposits are similar to those of the overlying nodular layer in knobby structure, wealth of glauconite and local concentrations of faunal remains, differing in less diversified rock content, i.e. the lack of typical, large nodules (concretions, pebbles), the nest-like accumulations of glauconite (inferred traces of channel infillings), and mainly in being more coherent and harder. In knobby limestones, similarly as in the nodular layer, fossils have thin clay-glauconite coatings which

indicate temporally impeded rate of sedimentation. The predominance of benthic fauna, mainly comprising brachiopods *Dorsoplicathyrus* and echinoids *Collyrites*, evidences small depth of sedimentary environment.

The nodular layer is the last lithostratigraphic member of the Callovian, bearing ammonites of the *Sigaloceras calloviense* zone (*S. calloviense* and *S. enodatum* subzones). Among predominating species of the Upper Callovian *sensu polonico* there were identified here *Macrocephalites* (*Macrocephalites*) *cannizzaroi* (Gemellaro), *M.* (*Pleurocephalites*) *lamellosus* (Sowerby), *Sigaloceras* (*Catasigaloceras*) *enodatum* (Nikitin), *Kosmoceras* (*Gulielmiceras*) *gulielmi anterior* Brinkmann, *Indosphinctes* (*Indosphinctes*) *patina* (Neumayr), the range of which falls within the above mentioned stratigraphic interval.

The oldest faunistic elements as well as some types of pebbles of the nodular layer may represent relics of top parts of knobby limestones destroyed by bottom erosion and redeposited at the beginning of formation of this layer. It should be noted that moulds of the bulk of Lower Callovian ammonites present in the nodular layer are made of somewhat different material than those of the Upper Callovian ones and often resembling underlying rocks. This infraformational hiatus and erosion were, however, not long as ammonites present in both the knobby limestones and the nodular layer display a continuous biostratigraphic sequence falling within the range of the *Sigaloceras calloviense* subzone.

A detailed discussion of Upper Callovian faunistic elements of the nodular layer will be given elsewhere in this chapter.

UPPER CALLOVIAN – LOWER OXFORDIAN, PARTIM

Zones: *Kosmoceras jason*, *K. pollux*, *K. duncani*, *Quenstedtoceras flexicostatum*, *Q. lamberti*, partim

The above mentioned nodular layer is overlying uneven top surface of the knobby limestones (Pl. III, Fig. 2), closely adjusting to its relief. Its oldest faunistic elements are discussed above, and general lithological characteristics is given in the chapter dealing with descriptions of outcrops.

The mechanism of formation of the nodular layer is still insufficiently known as neither detailed petrographic nor sedimentological analyses were carried out. It is widely assumed, however, that this is shallow-water deposit (S.Z. Różycki, 1953, 1960a; J. Znosko, 1954a, b, 1957; J. Kopik, 1967; M. Szulczewski, 1968; M. Giżejewska, 1975, and others), formed in result of infraformational reworking of not fully consolidated deposits. This seems to be evidenced by a high concentration of faunal remains, the presence of ooids in some places, as well as some traces of water agitation (effects of waving).

It may be assumed that there were a few phases of accumulation of deposits, followed by periods of sharp drop in the rate of sedimentation and finally scouring of still unconsolidated fine marly deposit. These phenomena resulted in a slow but steady increase in concentration of larger and heavier components of the nodular layer, such a phosphatic-calcareous nodules, bedrock pebbles, shells of molluscs and brachiopods and echinoderm skeletal fragments. These elements

Main stratigraphic subdivisions of epicontinental Callovian of Europe
 Ważniejsze podziały stratygraficzne epikontynentalnego keloweju Europy

Table 1

ENGLAND W.J.Arkel: /1956/ J. H. Callomon /1955, 1964, 1968/			FRANCE /submediterranean/ H. Tintant /1963-1964/ E. Cariou, S. Elmi, Ch. Mangold, J. Thierry, H. Tintant /1971/				USSR Russian Platform N. Sazonov /1964/		POLAND Cracow-Wieluń Jura S. Z. Różycki /1953/ Subdivision accepted here									
Lower Oxfordian	<i>Quenstedtoceras mariae</i>		Lower Oxfordian	<i>Quenstedtoceras mariae</i>		<i>Mariae</i>	<i>Præcordatum</i> <i>Scarburgense</i>		Oxfordian	<i>Cardioceras præcordatum</i> <i>Quenstedtoceras mariae</i>		Oxfordian	Divesian	<i>Quenstedtoceras præcordatum</i>		Lower Oxfordian	<i>Quenstedtoceras mariae</i>	
	Upper Callovian	<i>Quenstedtoceras lamberti</i>		<i>Quenstedtoceras lamberti</i>			<i>Lamberti</i>	<i>Poculum</i>		<i>Quenstedtoceras lamberti</i> <i>Quenstedtoceras keyserlingi</i> <i>Peltoceras athleta</i>				<i>Quenstedtoceras lamberti</i> <i>Quenstedtoceras flexicostatum</i>			<i>Quenstedtoceras lamberti</i> <i>Quenstedtoceras flexicostatum</i>	
Middle Callovian		<i>Erymnoeras coronatum</i>	<i>Kosmoceras gros.</i> <i>Kosmoceras obductum</i>		Middle Callovian	<i>Erymnoeras coronatum</i>		<i>Kosmoceras interpositum</i> <i>Kosmoceras grossouvrei</i> <i>Kosmoceras obductum</i>		Upper Callovian	<i>Coronatum</i>	<i>Grossouvrei</i> <i>Obductum</i>		Upper Callovian	Upper	<i>Kosmoceras duncani</i>		Upper Callovian
	<i>Kosmoceras jason</i>		<i>Kosmoceras jason</i> <i>Kosmoceras medea</i>				<i>Kosmoceras jason</i>	<i>Kosmoceras jason</i> <i>Kosmoceras medea</i>				<i>Jason</i>	<i>Jason</i> <i>Medea</i>			<i>Erymnoeras coronatum</i>		
Lower Callovian		<i>Sigaloceras calloviense</i>	<i>Sigaloceras enodatum</i> <i>Sigaloceras calloviense</i> <i>Proplanulites koenigi</i>		Lower Callovian	<i>Sigaloceras calloviense</i>		<i>Sigaloceras calloviense</i> <i>Proplanulites koenigi</i>		Middle Callovian	<i>Gracilis</i>		<i>Patina or Enodatum</i> <i>Michalekii</i> <i>Koenigi</i>		Middle Callovian	Upper	<i>Kosmoceras jason</i> + <i>Cadoceras milashevici</i>	
	<i>Macrocephalites macrocephalus</i>		<i>Macrocephalites kamptus</i> <i>Macrocephalites macrocephalus</i>				<i>Macrocephalites calloviense</i>	<i>Macrocephalites kamptus</i> <i>Macrocephalites macrocephalus</i>				<i>Macrocephalus</i>	<i>Posteriorum</i> <i>Boginense</i> <i>Pseudochanasiense</i> <i>Folliformis</i>				<i>Sigaloceras calloviense</i> <i>Sigaloceras gowerianus</i> <i>Cadoceras elatmae</i>	
Bathonian			Bathonian					Bathonian		Bathonian			Bathonian					
Bathonian			Bathonian				Bathonian		Bathonian		Bathonian							

